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sumption; and other fruits and nuts are cultivated, mainly in the North.

Livestock raising is an adjunct to agriculture rather than an integral part of it. Sheep and goats predominate because they thrive despite poor grazing and feeding. Sheep and goats, as well as camels, are kept primarily by pastoral nomads who probably number well over 200,000. Cattle and water buffaloes are the livestock of the settled agricultural population. Many peasants, however, have no livestock at all except for a draft animal or two. Livestock are left to forage for themselves, with only some supplementary feeding with straw and perhaps barley in the winter. Only livestock in and around the cities are systematically fed.

Crop yields are generally low. The water supply is frequently inadaquate. Agricultural methods have on the whole remained unchanged for centuries. Little or no animal manure or fertilizer is applied to the soil, animal dung being used largely for fuel. Crop rotation is wholly inadequate and makes little or no provision for soil-building crops. Salinity, attributable to poor drainage, has materially lowered the productivity of land in the irrigation zone. Owing to insufficient and poor draft animals and lack of proper equipment, the soil is often poorly prepared, and weeds detract from the yields. Up to half of the winter crop area is left fallow as a means of restoring fertility, but since the land is generally allowed to go up in weeds to afford grazing for animals, the efficacy of the fallow system is limited. The productivity of livestock is also low, primarily because of inadequate feeding, but also because of poor breeding, disease and insufficient shelter.

Except for some rather limited areas in various parts of Iraq and a promising settlement in the Dujaila district of south-central Iraq, the country is almost wholly devoid of peasant proprietors. The ownership of cultivated lands is largely in the hands of sheikhs and urban proprietors who entrust the actual cultivation in small parcels to sharecroppers. These sharecroppers have neither the equipment nor the knowledge to increase production and for the most part eke out a bare subsistence.[2] The land assigned to the

[2] According to the cadastral survey which is half completed, 67.1 percent of the privately-owned land is in units exceeding 1,000 donums. (One donum equals 0.25 hectares or 0.617761 acres.)

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new settlements the government will have a unique opportunity to remedy the shortcomings of the Dujaila project.

Improvement in Productivity

While expansion of land under cultivation, particularly through large irrigation schemes, is essential in the long run to provide for a growing population and to establish a socially desirable class of smallholders, it should not be undertaken without a simultaneous vigorous campaign to increase the productivity of agriculture and livestock. The temptation to neglect such an effort in favor of striking new irrigation schemes should be resisted. Among the measures upon which this campaign should concentrate are drainage, the provision of better tools, seeds and draft animals, the introduction of soil-building and forage crops, the use of fertilizers, the improvement of livestock, the planting of trees and the establishment of an effective extension or advisory service to farmers.

1. Drainage

The drainage of existing irrigated lands would make the most important single contribution to increasing the productivity of agriculture. Moreover, it will also have the most immediate effect since it can be carried out by the government while the success of virtually all other measures to raise productivity depends on the necessarily slow process of persuading farmers to abandon age-old methods of cultivation.

The Haigh Irrigation Commission, which made an extensive study of irrigation and flood control for the government, estimated a few years ago that about 60 percent of the land irrigated by flow had been seriously affected by salt. The Mission's own inquiries and observations indicate that as much as 20 to 30 percent of cultivated land has been abandoned over the last few decades because of salt accumulation, while on a large part of the remaining land yields have declined by 20 to 50 percent and even more. In a number of new irrigation projects such as Hawija and Dujaila salting forced abandonment of part of the land within two years after the schemes were initiated. Drainage, almost totally neglected in the past, should therefore be prosecuted with utmost vigor in the future.

The main drainage canals for the whole irrigation zone have been projected, but it is now necessary to proceed with detailed

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IV. Natural Resources

Land and Water

312 Aside from oil, water and land may be said to be the principal natural resources of Iraq. Of the two, water is the more critical factor in the country's development. Underground water is generally plentiful, but in parts of the North it is frequently found only at considerable depth and in the central and southern portions, where the water table is high, it tends to be brackish and unfit for consumption. In the two major rivers, however, Iraq possesses a source of abundant water of a quality excellent for irrigation and, with purification, for human consumption. Here the chief problem lies in the marked variation of the flow of the rivers. On the Euphrates the mean monthly discharge of water varies from a low of 293 cubic meters per second in September to a high of 2,235 in May. On the Tigris the variation is even more marked, ranging from a low of 359 in October to a maximum of 2,951 in April. Thus periods of floods alternate with periods of acute scarcity. In the absence of storage facilities and a regulated flow, the limit on the cultivation of crops is set by the current low point in the water supply in the critical growing period for both winter and summer crops. The water problem is further complicated by the fact that continuous use of water for irrigation, coupled with the effect of evaporation in a dry, hot climate, has saturated the subsoil waters with salt and raised the water table, thus precipitating salt which, in the absence of drainage, quickly makes the land infertile. More effective use of the water supply is thus the central problem of Iraq.

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311 In relation both to the population and the land actually under cultivation, the amount of cultivable land available in the country is very large. Accurate statistics on the total cultivable area are lacking, but the following estimates based largely on data supplied by the Department of Agriculture give some conception of the magnitude:

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to keep the river bed deep enough to prevent the formation of additional outlets at flood times. These measures should then be complemented by a series of small works to provide proper control of the canals themselves. The Mission suggests that no regulator barrages be built across the Tigris itself until the results of these control measures are known. Meanwhile, the program should improve the navigability of the river and assist in draining the marshes.

As in the case of the Shamiya district on the Euphrates, the program for controlling the lower reaches of the Tigris will make adjustments necessary in the rice-growing areas of Amara. Here, too, it is therefore important that the Department of Agriculture provide timely assistance and advice to cultivators in adapting to the new water regime.

III. Drainage

While new irrigation schemes always appeal to the popular imagination, it would be exceedingly unfortunate if they should continue to be carried out, as in the past, to the neglect of essential drainage. Lack of drainage facilities has resulted in progressive salination and deterioration of the soil. In such areas as Hawija and Dujaila salt has become a serious problem within only a few years from the time irrigation was begun. Almost all land irrigated by flow has become salty to some degree, resulting in declining crop yields. The only conspicuous exception is the land in the Diyala River Valley for which the river, which has cut a deep bed from the Jebel Hamrin range to its confluence with the Tigris, acts as a natural drain during the dry season. Pump-irrigated lands generally suffer less from salting, partly because they are higher and thus tend to have better natural drainage and partly because, owing to the cost of pumping, there is an incentive to avoid the lavish use of water which tends to waterlog the soil.

The Haigh Commission estimated that about 60 percent of the irrigated areas have been affected by salt. The Mission's own observations indicated that perhaps 20 to 30 percent of the cultivated land in the irrigated areas has been abandoned during recent decades owing to the accumulation of salt and that yields on the

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312 134 land still being tilled may have declined by 20 to 50 percent. The situation appears to be worst in the regions fed by canals controlled by the Hindiya barrage on the Euphrates. Thus about half of the lands irrigated by the Beni Hassan canal and 40 percent of those served by the Kifl canal have become too salty for winter cultivation.

The waters of the Tigris and Euphrates do not themselves contain excessive quantities of salt. Water is generally regarded as perfectly suitable for irrigation as long as the proportion of dissolved salts by weight does not exceed 70 parts in 100,000. Available analyses of the Tigris at Baghdad indicate that the proportion does not exceed 30 to 33 per 100,000 at most. For the upper reaches of the Euphrates the proportion is the same or even less, but in the lower Euphrates, which receives the drainage waters from the irrigated areas, the proportion may go as high as 90 parts per 100,000 in the fall of the year. (See Table III in the appendix.)

Salt has, however, become concentrated in the subsoil waters. The presence of some of the salt may be due to the fact that much of the land was originally under the sea. In the long run, however, it has been the continuous irrigation or flooding of the soil, combined with the effect of evaporation under the hot summer sun, which has led to a progressively greater concentration. Irrigation and flooding keep the water table high with the result that capillary action brings the water up into a zone where it evaporates under the heat of the sun and precipitates salt. Frequently cultivators resort to lavish use of irrigation water in order to wash the salt away from the roots of the crops. In the end, however, this practice has only worsened the situation by tending to raise the water table still further.

Salt accumulation can be prevented and existing salt evacuated only by digging drainage canals which will lower the water table to a level of 1.5 to 2 meters below the surface where capillary action can no longer be dangerous. Under such conditions water used in irrigation will wash away the salt deposited in the root zone and return it to the subsoil water which will be tapped by the drainage canals. Fortunately the salt found in the soil is not the sodium carbonate or "black alkali" type which cannot readily be washed away by water. Owing to the low level of the land the

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salty water accumulating in the drainage canals will in most cases have to be evacuated by pumps.

Up to the present, drainage has been the subject of little planning or experimentation in Iraq. Mr. J. S. Turcan, the drainage expert of the Haigh Commission, carried out a drainage study for the Aggar Qub region, which is irrigated by the Saglawiyah and Abu Ghuraib canals. It was found that of the total area of 320,000 masharas, 197,000 needed drainage. Experiments indicated that a flow of 1.0 cumec per 1,200 marsharas over a period of two and a half months rid the soil of salt to a depth of two meters provided drains were installed with a maximum spacing of two kilometers and sufficient depth to keep the water table from rising to a level higher than 1.75 meters from the surface of the soil. The cost of a drainage project for this region, inclusive of the cost of a pumping station to evacuate the drainage waters to the Tigris, was estimated at ID 279,000 per 150,000 masharas or ID 1.86 per mashara. Preliminary plans have also been made for the drainage of other areas. One of these was for the area served by the Beni Hassan canal where the drainage of 330,000 masharas was estimated to cost ID 750,000 or ID 2.26 per mashara. The Haigh Commission came to the conclusion that the cost of drainage would average ID 2.0 per mashara or a total of ID 8,160,000 for 60 percent of the area now under flow irrigation.

Drainage might be usefully complemented by steps to line canals at points where there appear to be excessive losses of water through seepage. Such losses may lead to waterlogging of the soil and a resulting rise in the water table. Since Iraq is rich in asphalt, a lining of bituminous concrete might be best.

Deterioriation of land through salting has become such a serious problem that immediate steps should be taken to initiate drainage on a large scale. The Mission urges that work on the main drains be begun as soon as plans can be completed. At the same time complete drainage systems should be laid out and constructed for areas where the salt problem is most acute, notably those irrigated by the canals dependent on the Hindiya barrage. A start might be made with a drainage system for the Aggar Qub region since it has already been carefully studied. Early steps should also be taken to drain the Hawija and Dujaila areas. The

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312 experience gained with the drainage systems first completed, par-
134 ticularly with respect to the depth and spacing of secondary drains,
● will be useful in planning subsequent schemes.

It is important also that drainage facilities be incorporated in any new irrigation schemes. It is always more costly to provide a drainage network for an already existing irrigation system, since it generally involves cutting across irrigation works and splitting up parcels of land. The installation of drainage facilities will be of vital importance for the rice-growing region of Kufa-Shamiya which the Mission recommends converting to a controlled flow-irrigated area. The same is true of the marshy region along the lower Tigris for which the Mission has suggested a number of control works.

The Development Board has allocated ID 2,000,000 to drainage in its five-year program. The Mission recommends, however, that at least ID 7,000,000 be devoted to this purpose over the next five years. Drainage works for the new irrigation projects alone would cost ID 5,600,000 on the assumption that about 60 percent of the area involved would require drainage. The Mission suggests that part of the cost of installing drainage facilities in existing irrigated areas be paid by the landholders who are benefited. This would be an equitable arrangement and need not be unduly burdensome if payments are spread over a number of years. Landowners, however, should not be given the option of participating in a drainage scheme, for the construction of an integrated drainage network requires the inclusion of all the land within a given area.

IV. Operation and Maintenance

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With attention focussed on the construction of reservoirs and new irrigation systems, there is a great danger that maintenance of existing irrigation works will continue to be neglected as in the past. There are many signs of such neglect today. Regulators have fallen into disrepair; canals have become silted and have developed bad leaks. False economies in the original construction and the use of poor materials have often made the task of maintenance more difficult. Thus frequently there has been no provision for roads

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state-owned agricultural land. The system of cultivation is prescribed. Thus 40 donums must be devoted to winter wheat and barley and five donums to summer crops. In addition five donums are to be planted with fruit, although evidently only 350 of the older settlers have such gardens in which grapes, greengage, apricots and date palms have been planted.

On the whole, the Dujaila scheme has been conspicuously successful. There is no doubt that the settlers who formerly were poor sharecroppers are now far more prosperous and contented. Most of them are obviously proud of their accomplishments. Their mud houses, although not built according to standard specifications as originally planned, are larger and more substantial than those of other fellahin. As already indicated, interesting experiments with cooperative organization have been carried out. In addition a useful start has been made with the planting of trees along roads and boundary lines.

The Dujaila venture has not, however, been an unqualified success. The failure to install drainage facilities has led to progressive salination and already some of the land has been abandoned. The administrative staff on the spot totals 75 people. Even after allowing for the fact that the staff also controls the distribution of water within the scheme and the operation of two nurseries, this number seems excessive. Aside from insisting that five donums be planted to fruit trees, nothing has been done to improve agricultural and livestock practices. Thus the increased prosperity of the farmers is solely due to the fact that they have more land to till and do not have to surrender a share of their crops to a landlord. There is no agricultural extension service on the spot capable of working with the farmers. In fact, the Department of Agriculture is not even represented on the committee which directs the scheme. Two nurseries are located in the scheme, but they serve simply to supply fruit trees for garden plots and other trees and cannot in any sense be considered demonstration units. It is generally agreed also that the scattered mode of settling the people was ill-advised, since it ignored the need for a community life and made it difficult to provide such community facilities as safe water, schools and health centers.

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level plains and raise, by means of the scanty rainfall, a meager amount of wheat and barley in favorable seasons.

Along the rivers in their upper courses are a few gardens, irrigated by means of various draught animals and water-wheels, which elevate water from the stream to the level of the land above. At Gurna the Tigris and Euphrates join to form one river and at Mohammerah the Karun empties into this united stream. The three rivers thus flow into the ocean as one enormous waterway, known locally as the "Arab River." For the last hundred miles before the sea is reached, the fresh water of the river ebbs and flows with the tides, and by cutting outlets along the river banks gardens may be automatically irrigated twice a day if so much water is desired. Along these lower stretches each bank of the river is lined with beautiful gardens, which reach a depth of some miles in places and extend in practically an unbroken expanse all the way up to Basra and in less prolific culture even as far as Gurna. These date gardens are beautiful things, beautiful for what they are now, and more beautiful still as a suggestion of what all Mesopotamia might be. They are also one of the most melancholy things in the world as reminders of what the past developed and the present has wasted.

The land has enormous resources for agricultural development. That whole vast district may be made into the garden spot of the earth. The soil is the best in the world, river silt hundreds of feet deep. It is as level as a parlor floor, with just enough pitch between the big rivers, and between the north and south, to make irrigation easy. All that is necessary is a perfected system of irrigation, and although the necessary investment would

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Tigris, and a large reservoir at Bekhme in the mountains on the Great Zab. 312
The Mission endorsed these projects and recommended others to compensate for diversion and to balance the systems.

The Iraq Irrigation Development Commission believes that the area under irrigation can be increased to 12 million acres by the installation of additional storage facilities, by drainage, rehabilitation, and by new supplies of water.[44]

It is agreed generally that the rain-fed zones in the north must continue to depend primarily on rainfall. Although no accurate estimates are available, the total area which might be available for cultivation in this area is thought to be substantial.

Along with irrigation, an important means of improving productivity is 241
drainage. This would have an immediate effect; other proposals depend on 311
the necessarily slow process of persuading farmers to abandon age-old methods of cultivation.

As much as 20 to 30 per cent of the cultivated land is said to be abandoned because of salt accumulation. On a large part of the remaining land, yields have declined as much as 50 per cent. Drainage—almost totally neglected—the report concluded, should therefore be prosecuted with utmost vigor.[45]

MECHANIZATION

Because of the cost, the Mission predicted that mechanization would pro- 241
ceed slowly. This conclusion was reached in the face of experience which 407
shows that tractor ploughing may increase yields 20 to 50 per cent, largely through more effective destruction of weeds and better preparation of the soil.[46] No doubt mechanization will become increasingly important as additional land is placed under cultivation and labor becomes scarce.

About 750 tractors and 320 combines are in the country at the present time. A government agency owns 75 of the combines and 81 tractors and plans to import an additional 2,500 tractors and 550 combines with auxiliary equipment.[47] About 50 per cent of the machinery will be retained at government-owned tractor stations and rented or let out under contract.[48] The rest will be sold on easy terms to the farmers.

The International Bank approved a modified version of this machinery program but suggested that rental charges be increased to make the project self-sustaining, and adequate repair shops and demonstration and training programs were recommended.

SOIL BUILDING

It is obvious that the fertility of the soil needs to be replenished. [134] 242

Cultivation of soil-building and forage crops is said to be virtually unknown. Attention needs to be given to the production of legumes. Commercial fertilization must be studied and, if possible, plants should be built to produce inorganic and organic materials. Soil analyses also are generally needed.

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44 *Economic Development of Iraq*, *op. cit.*, p. 16.
45 *Ibid.*, p. 17.
46 *Ibid.*, p. 18.
47 *Ibid.*, p. 19.
48 *Final Report of the United Nations Economic Survey*, *op. cit.*, p. 33.

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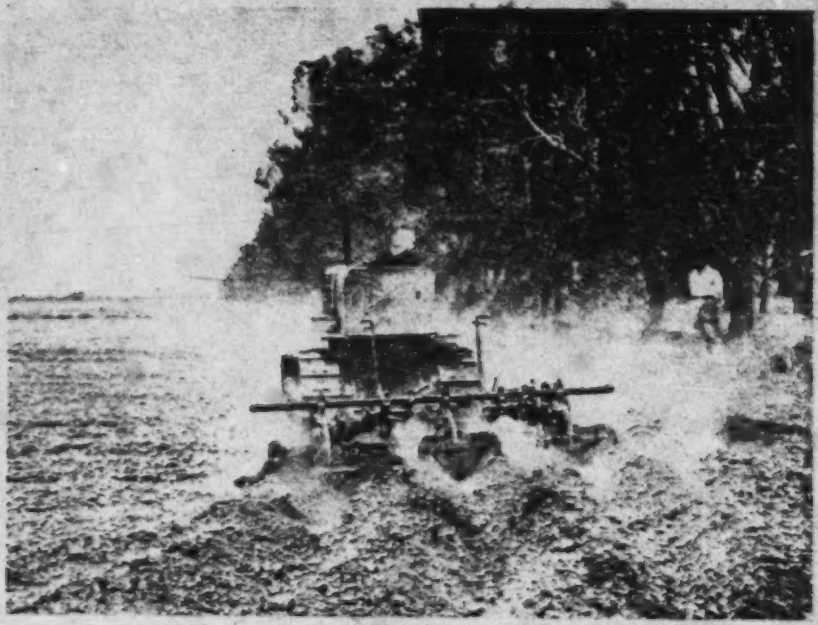
COTTON IN IRAQ



—*Photo Courtesy of Technical Cooperation Administration*

Modern tractors with gang ploughs are now in general use in Iraq for ploughing cotton. Because the land is so heavy, tractors are usually of the heavy-duty track type. Most of the tractors are owned by the government and rented with drivers to farmers on an hourly basis. The Iraq Government is conducting experiments with all types of mechanical equipment in the hope that new lands in the rainfed areas to the north, too sparsely populated to farm with hand labor, may be brought into production with complete mechanization.

These plants have been found to set 75 per cent of their bolls before the end of August.

Dr. Shelby Cain, cotton agronomist from Texas A. & M. College supplied by the Point Four Program, is concentrating on this problem in the cotton breeding program. He will be assisted by two Iraqi specialists now being trained at Texas A. & M. To some observers it appears that more work is needed on cultural practices before a full program on cotton breeding is started. For instance, the influence of planting dates, irrigation, fertilization, and cultivation on plant growths in this environment needs to be investigated before the more fundamental research in genetics and breeding can be used effectively.

Fertilization

Research on the problem of maintaining soil fertility is needed also and is included in the broad program for the future. There is an obvious deficiency of nitrogen and humus in the soil, and probably other plant foods. Much of the land in both of the main valleys has been under continuous cultivation

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242 134 for centuries, and farmers have depended on the silt deposited from the overflows to maintain the fertility. Increased use of canals and dams for irrigation has made the overflows less frequent. Experiments conducted for the past three or four years with commercial fertilisers have shown no significant benefit, but the United States experts feel the tests are not conclusive and should be continued with various soil conditioners.

While depending on basic research to stimulate long-range production, the Director General is trying to force an immediate improvement through regulations requiring the application of techniques known to be beneficial.

248 656 *Controls*

In an effort to concentrate cotton production on the better suited lands and to facilitate insect control, seed control, and other beneficial measures, regulations have been promulgated requiring government permits for all cotton acreage planted. These permits, based primarily on suitability of the soil and availability of water and labor, are issued on the recommendation of local representatives of the Ministry of Agriculture. However, the enforcement system is inadequate, and it is generally admitted that the regulation is not closely followed, especially in areas where the local sheiks are extremely powerful and are practically a law unto themselves.

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—Photo Courtesy of Technical Cooperation Administration

At the government cotton experimental farm near Baghdad a double-handled board is used to level the high spots in a newly ploughed field. Outside the government farms little leveling is done. Through the Point Four Program the United States is cooperating with the Iraq Government in experiments and demonstrations to improve cotton cultural practices.